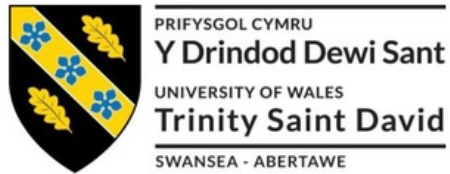


Major Project

by Rhys Howells

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Internet of Everything – App Tap Your Light Switch

By

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A project submitted in partial fulfillment for the degree
of BSc. (Hons) Computer Networks.

April 2016

Declaration of Originality

I, Rhys Howells declare that I am the sole author of this Project; that all references cited have been consulted; that I have conducted all work of which this is a record, and that the finished work lies within the prescribed word limits.

This work has not previously been accepted as part of any other degree submission.

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I, Rhys Howells consent that my Project, submitted in candidature for the B.Sc.(Hons) Computer Networks degree, if successful, may be made available for inter-library loan or photocopying (subject to the law of copyright), and that the title and abstract may be made available to outside organisations.

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Abstract/Synopsis

This paper looks to convince the world to move from the Internet of Things (IoT) era and move into the next stage of the Internet; The Internet of Everything. The paper looks at where everyone is in the world of Internet and what companies are doing to improve connectivity in their products to improve the worlds homes. The paper evaluates the main advantages of having connected homes and the constraints of implementing such technologies. To persuade integration of Internet of Everything, App Tap Your Light Switch was designed and explained in this paper to target audiences to improve connectivity in their homes. App Tap Your Light Switch is a web-based application (Raspberry Pi) used with a microcontroller (Arduino) to change the state of the light remotely over the Internet using a Virtual Private network (VPN). Evaluation of the design looks to persuade the audience to integrate this into their lives and homes to improve connectivity as an alternative to purchasing products by MNC and paying over the odds for a product that can be made for less than £30.00 and offering practical experience to anyone wishing to learn coding and hardware wiring of a circuit.

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Chapter 1

1.1 Introduction

App Tap Your Light Switch is a new idea which was thought of as a way of controlling your lights around your household via a device connected to the home network.

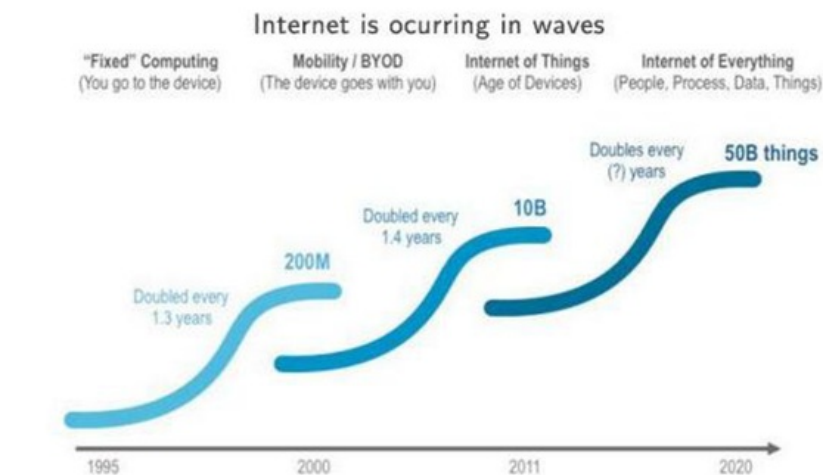
Scenario – Picture yourself as a person with a 2-bedroom house; you as the man or woman of the household is responsible for the bills and the upkeep of the house – you one morning before going to work, leave a light on in one of the rooms with nobody in the house to turn it off. You will be gone for the whole day – leaving the light on for 12 hours. Next time your bill is due you find out that this has been happening too many times and has increased your bill significantly.

This is where *App Tap Your Light Switch* comes into play.

The main reasoning behind this potential system came from a well-known company, ‘British Gas’. They have developed a system which is called ‘Hive’, that was introduced to British Gas customers as a way of controlling the heating in their household and water from a smartphone which you can use “*anywhere, anytime*” [1] as long as you’re in a Wi-Fi hotspot.

The Internet of Everything, interconnecting devices and communicating through a network of networks; it is interesting to think how you can communicate with a device just by being connected to the Internet. Using an app to turn off a light in a house sounds outrageous but compared to what you could also do in your home – Controlling Kitchen Appliances, Toasters, Microwaves even TVs and Computers. It is endless and can be explored outside of your home, it only takes one chance for technology to be exposed before a chain is created; just like British Gas Hive system has inspired this potential software.

Dave Evans [2] first introduced us all to the concept of the 'Internet of Everything'. An astonishing '*10 to 15 billion devices*' were on the Internet then; with that figure expected to double by 2020 according to Cisco. However, an incredible statistic of '*Less than 1%*' were not connected to the Internet.



Source: Cisco IBSG, 2012

Figure 1: Dave Evans - *The Internet of Everything, How More Relevant and Valuable Connections Will Change the World* [3].

The world today is full of technology, with gadgets and computers introducing a new way of sustainability. Technology has been at the for-front of updated systems and organisations the past few decades; as a way of improving efficiency and diversity in performance compared to human initiative. With emerging computing ideas; we humans are in no doubt arguing with the fact that technology provides us all with re-assurance and practicality, leaving some of us with no choice but to implement this into our everyday lives. A Journal discussed by Bojanova, Hurlburt and Voas [4] explained the status us humans are at in the world of technology. Internet of Things (IoT) and how the next stage that we are all 'Imagineering'; Internet of Everything.

This dissertation paper involves a prototype designed to improve connectivity within a household. This experiment will prove how you can approach essential equipment in your household such as a light in this scenario and use it in a remote way; providing an Internet connection is available to control its state to on or off. The paper will also promote not just ability to control lighting in your household but perhaps more ambitiously the 'whole' household. Again, already thinking about the next step in the world of Internet. Also to accompany the prototype, the public sector of Swansea will provide a second opinion and a review on the prototype in terms of efficiency, practicality and usability. All these factors will determine the way the project is promoted in the Exhibition. Research into the various types of technologies around on the Internet today will be carried out and used to inspire and bolster the world of 'Internet of Everything'.

1.2 Aim

The main premise of this project is, the world today needs to be 'more connected'. Based on research and analysis into the '*Internet of Everything*'. Improving how people implement such technology can promote this idea and moreover can push us into the right direction; towards the next stage of this evolution of connectivity.

The project aim is to develop a web-based application using php that can be used adjacently with a programmed raspberry pi and some electronic appliances (a relay, microcontroller and a light) to turn a lights state to on or off over the Internet via a VPN connection.

1.3 Objectives

The main project will be split up into a number of objectives, these objectives are as follow:

- Research chosen topic as a whole – is it a SMART project?
- Create a questionnaire/survey to understand the public of Swansea' views on emerging technology – also complete the ethics form to allow this primary research.
- Research and collect key electronic and software parts to design and craft the prototype planned.
- Research into the Internet of Everything – what are others contributing to the IoE?
- Create a project plan - to schedule activities that will be key to constructing both the prototype and the report itself; using this for management purposes.
- Design and construct a BPMN diagram and a Schematic diagram for the web-based application in php.
- Design the prototype, fitting validation checks; and making sure that the program is converged with the raspberry pi – therefore making the model viable.
- Expose the finalised guidelines for critique and evaluation.

1.4 Structure of the Project

The project will be structured accordingly; the first part will be the secondary research, analysing the theoretical side of the project which will support the findings as a whole. The next stage is designed to focus on the prototype in general; understanding the components used based on the research made and what makes the product tick. This stage will show the design of the prototype and covers the methodology used in creating the design. The final stage, will be aimed at testing the prototype from simulations and then reported on. The other feature would be

the appendices, references, surveys and bibliography. Below shows the setup of chapters:

Chapter 1 focuses on the theoretic side of the report; topics such as the 'Internet of Everything' and more in depth understanding of what other companies are doing to bolster this way of connectivity. Also, the tools discussed which could influence the project with comparisons to show a general debate in the topic provided.

Chapter 2 discusses more in depth the components chosen for the prototype design and how it is possible to converge these into one application.

Chapter 3 involves the waterfall method such as the feasibility study (method of which to carry out a task), requirement analyses and specification (what the end user wants? or what it should require?), system specification (what the system should do?) and finally the physical design (what the prototype will look like?) – This covers the web-based application and the physical hardware components converging together.

Chapter 4 looks at the prototype an in-depth analysis of the final product and the testing. Moreover, a final look at the work and how it has covered the specification in the last chapter.

Chapter 5 looks at the conclusion of the product which links to the testing in the previous chapter. Does the prototype work effectively? Evaluating if the aim of the project has been met accordingly.

Chapter 6 looks at the conclusion overall, and what recommendations could influence future improvements.

Chapter 7 has the appendix, references, and the surveys produced in endeavour to find out what the people of Swansea think of emerging technology and the idea of having a product which was proposed in their household. Underlining the personal reflections made from completing the product and the report to underpin what went well and what didn't; with additional suggestions for improvements.

Chapter 2 - Research & Review of Literature

2.1 Internet of Everything

With all this information situated with endless growth of devices imported into the forever changing Internet; the key requirement for future terms is improving connectivity with devices. That 1% connected to the Internet has inspired development prospects and has inspired the potential of having an Internet that can be connect to ‘Everything’ not just ‘Things’.

More recently, British Gas incorporated a new way of connectivity with their products. In 2012, the UKs leading energy supplier developed a product called ‘Hive’. Built for the soul purpose of making the *“connected home a reality for everyone”* and to *“give customers more control over their lives and homes”* [1]. The idea of the product was, British Gas customers could use ‘Hive’ in their household to control remotely their heating from a smartphone and/or computer.

This best describes the Imagineering of the ‘Internet of Everything’ where not only the basic technologies such as phones, tablets and computers are converged but other home appliances and essentials too. British Gas have realised that the controlling of heating in our homes can be a potential system to boost their profits and help to move that one step ahead from the ‘Internet of Things’.

2.1.1 Mobile Data

Furthermore, turning the Imagineering process into real-time would be the invention of generation mobile data over the past few decades to start off the world of Internet of Things (IoT) and bolster the world of Internet of Everything (IoE):

1G: In 1970, the first generation of mobile data was introduced and referred to as cellular or ‘cell’ as later known. 20 million of the worlds population were involved and used this generation by 1990.

2G: 1990, was the introduction of ‘Global System and Mobile Communication’ – which focused on ‘voice quality’ but had ‘limited data service’ [5]. Later on added the addition of “*paging, faxes, text messages and voicemail*”.

2.5G was introduced later and involved ‘packet switching’ capabilities and the production of the “*Internet*” - the Internet Protocol.

3G: More recently, this was the age of the ‘video, audio and graphics applications’. Persons that had 3G would be able to ‘watch streaming videos’ and ‘engage in ‘video telephone’. Although there were problems with the limitations it offered and the over-usage that caused problems (especially with high demand). 3G offered speeds of ‘2 Mbps’- however that was in good conditions and stationary.

4G: The main aim for this generation was to improve speeds to ‘20 Mbps’ and maintaining Quality of Service features. The main QoS was to separate telephone and Internet lines – ‘prioritizing traffic’ so delays do not feature when switching ‘at a moment’s notice’. 4G was put in place to improve the delivery of data by allowing ‘wider bandwidth to vehicles...’ and ‘devices moving at high speeds within the network area’.

2.1.2 New Generation of Mobile Data (5G)

A journal produced by Terez Pultarova, focused his paper on the new generation of mobile data. He claimed “*The technology, referred to as 5G or tactile Internet, has been the talk of this year’s Mobile World Congress (MWC) in Barcelona*” [6].

“*Downloading a full HD movie in less than three seconds, connecting myriad electronic devices to the Internet of Everything, unlocking the true potential of driverless cars...*” and “*allowing people to virtually ‘touch the Internet’*”.

Those are just some of the features that the new generation of mobile data are offering.

The paper also discussed, how the new 5G model could be rolled out as early as 2018 aiming for “*earlier trials in 2018 at the Pyeongchang Winter Olympics*”. With that date projected “*it can meet the 2020 5G roll-out deadline*” that the “*International mobile networks community*” set by itself.

Based on these both case studies; the Internet of Everything is reaching its target date with mobile data becoming more connected than ever, allowing downlink speeds of more than 2Gbit/s – and therefore encouraging high definition ‘streaming’ videos, video calling and so many more features across the Internet with a targeted “1 millisecond” latency on top of that “your able to virtually touch the Internet”.

As well as business such as British Gas opting to improve their products to accommodate the Internet of Everything and push consumers into migrating. A notion must click that the world is approaching the IoE. The worlds demands can now be fulfilled but only to encourage more greed into the forever changing world of technology and connectivity.

2.2 Previous Designs

Research into ‘remote controlling of lighting in your home’ has led to sites such as Amazon, Belkin and many more which have implemented and designed suitable hardware component such as a Plug-in ‘*Energenie Remote Control Socket*’ [7] for instance, as a suitable product for controlling your light and other appliances in your home such as heating etc. These products are highly recommended and are being purchased from these sites; and appeal to people who are not into ‘technology’ as of such. Out of 503 people that reviewed the product – 331 customers rated it 5 star; one customer calling it “The Best Remote Controlled Sockets”.

Whilst companies have developed products fit to help non-IT related persons integrate remote controlled lighting in their household others however; not connected to a well-known company and therefore a solo party have developed more advanced ways of turning a light state to on or off.

‘*Geo Bruce*’, a Belgium born student uploaded an “*Arduino Internet Controlled Desk Lamp*” design which was advertised on www.instructables.com (a website forum designed for persons to upload and share a particular products created for others

to view and comment on). Geo claimed that he has “a wide variety of interests: electronics, computers, technology” [8].

Geo used a “*linux web-server with PHP, an Arduino, a relay*” and “*some other components*” – this relates to the project proposed in this report; as it involves php and producing a web-based application. However, Geo has integrated an Arduino circuit board that interacts with the physical light to converge as a working prototype.

2.3 Arduino

Yusuf Abdullahi Badamasi produced a journal based on the ‘*The Working Principle of an Arduino*’ [9]. Badamasi referenced a paper from M. Banzi, ‘*Getting Started with arduino*’. Banzi explained that an Arduino is an “*open-source platform used for constructing and programing of electronics*”

Yusuf explained further as to what an Arduino is, he quotes:

“Arduino is a circuit board with chip that can be programmed to do numerous number of tasks, it sends information from the computer programme to the Arduino microcontroller and finally to the specific circuit or machine with multiple circuits in order to execute the specific command”.

He also described:

“An arduino can help you read information from input devices such as e.g Sensors, Antenna, Trimmer(potentiometer) e.t.c ...and can also send information to output devices such as LED, Speakers, LCD Screen, DC motor e.t.c”

Yusuf discusses how simple the Arduino works in terms of configuring or uploading a new piece of code. A “*USB cable...*” can be used to “*upload*” and the “*software of the Arduino uses a simplified version of C++*”

The Arduino consist of the following components [9]:

- USB Plug – ‘*used to upload a programme to the microcontroller*’ and powers on the board.

- External Power System (if need to give an extra supply of power for programs that need more sufficient power resource).
- Reset button – Resets the Arduino board.
- Microcontroller – “*receive and send information*” to the circuit.
- Analog Pins (0-5).
- Digital I/O Pins (2-13).
- In-Circuit Programmer – A “source to upload or programme your programme”.
- Digital and Analog Ground pins
- Power Pins

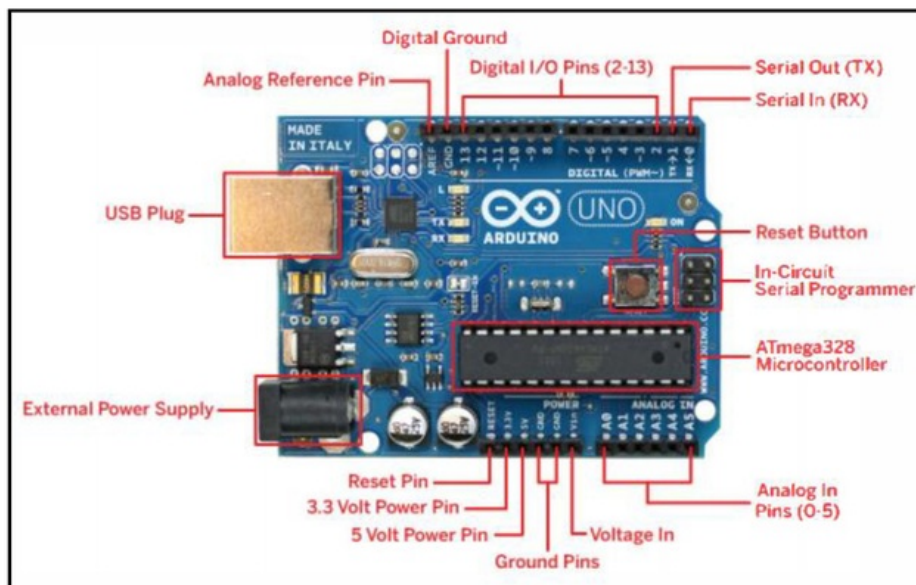


Figure 2: P. D. Minns, *C Programming For the PC the MAC and the Arduino Microcontroller System*. Author House, 2013 [9]

2.3.1 Raspberry PI (Alternative Solution)

The Raspberry pi, a simple electronic device developed in 2012 in aid of ‘*encouraging basic computer science in schools*’ [10] has been reinvented and applied to important mainstream products.

The raspberry pi was discussed and reviewed by Chris Edwards in a journal titled ‘Raspberry Pi gets big ideas’. The device was being exploited by major developers *“who see it as a cheap (circa £25) and effective way of getting compute power into a range of commercial-class solutions requirements”*.

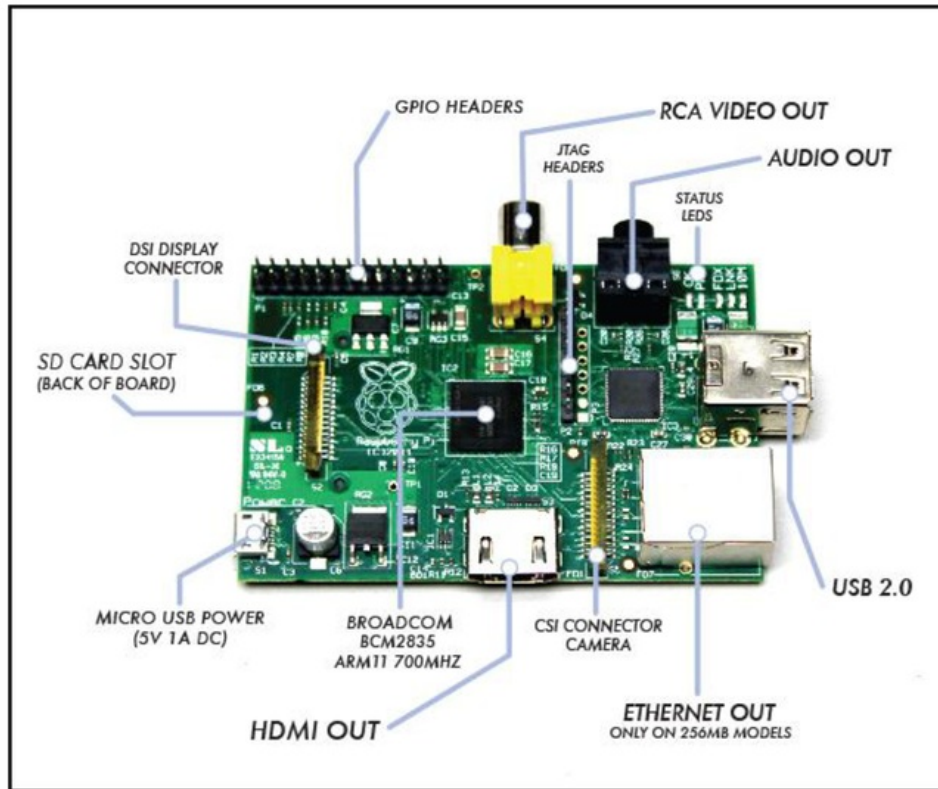


Figure 3: Raspberry Pi, Google [11]

Crispin Andrews’s paper focused on what the characteristics of a raspberry pi [12]. The pi is a ‘motherboard’ and consist of a ‘microchip’ inside;

“A Broadcom SoC; a 700MHz ARM11 processor handles basic computations – inputs, outputs and calculations; and there’s also a Videocore 4 graphics processing unit”.

The main attribute of this device is the power usage; which means that the computer stays “relatively cool”:

“The original model has 512MB RAM, 2 USB ports and an Ethernet port”.

The main Operating System used on a raspberry pi is Linux:

“Linux has low memory overheads, so it is possible to run a fully functional operating system on a simple device with no permanent storage”.

Also:

“Linux often comes with programming languages already installed. Scratch and Python work on the Raspberry Pi...”

The raspberry pi would be the best solution for implementing the proposed design; in terms of the cost, the simplicity and the effectiveness that it entails; however, a greater understanding of Linux and Apache would be needed to implement this into the final product.

2.4 Linux

Linux is an open source operating system. Nowadays, other more updated operating systems such as Microsoft and Apple Mac are implemented on workstations at home and/ or in workplaces. Main reason is the security features and the common feel of a graphical user interface. For many people, the likes of Microsoft and Apple Mac are user-friendly and are used throughout education and then future workplace jobs.

Linux is not the best in terms of usability and effectiveness especially if you have been working with other OS' such as Microsoft or Apple Mac.

What makes Linux a contender for the proposed system? Main reason is, the system that will be designed involves a web server using MySQL and Php. Linux is compatible with both parties and has a tool built in called 'Linux Apache' which acts just like a web server – and to add to this asset it is also open source.

2.4.1 Linux Apache

Apache is a HTTP server which supports Power over Ethernet and works with Linux OS. It is used to respond/send requests to and from a client connected to it.

HTTP' job role is to:

- Accept requests from clients and send responses to those requests.
- Obtains URL, translates it to a filename (for static requests).
- Transfers that file back over the Internet from a local disk/or translates it to a program name (for dynamic requests).
- Completes it, and then sends the output of that program back over the Internet to the requesting workstation.

Apache uses a TCP/IP to communicate packets and data across a network; whilst establishing a connection with hosts. Both protocols are vital to send and receive data.

Based on the proposed raspberry pi; integrating both the Linux OS/Apache and MySQL (Phpmysql) this project can labour like clockwork. With all tools discussed above in this chapter all are compatible with one another. No constraints are obvious; software components are open source and the hardware component (raspberry pi) has a cheap retail price.

2.5 C++ or Python?

To design and implement a web-based application, vigorous research was involved to find an effective programming language which could converge with the idea of remote switching of a light.

C++ was labelled by *Du Ruiqing* and *Li Xiaohui* as “... a middle-level language, as it comprises a combination of both high-level and low-level language features. It supports procedural programming, data abstraction, object-oriented programming, and generic programming” [13]. Whilst also being suited for “... students who learn computer science or engineering”. C++ is an “Object-oriented program” or otherwise known as “OOP” for short. This programming language uses “programming paradigm” which is basically ‘objects’ and connections that help to design and craft together a working application or program. It also uses “Procedural programming” which means it creates “routines, subroutines, methods” and “functions”. These tools help to structure the program and also benefits methods of ‘troubleshooting’. Based on what *Du Ruiqing* and *Li Xiaohui* have explained in their paper, C++ is an important and widely used programming language; especially for beginners looking to try out their programming skills and also for those who are completing degrees in computer science or engineering. However, is there another language out there, that ‘competes’ with C++ for practicality and usability constraints?

Code Listing 1 -- Comparison of Code for simple addition and output in Python and C++

Python	C++
x = 2	#include<iostream>
y = 3	int main() {
z = x + y	int x, y, z;
print(z)	x = 2;
	y = 3;
	z = x + y;
	cout<<z<<endl;
	}

Figure 4: C++ or Python? ‘Which One to Begin With: A Learners Perspective’
Muhammed Ateeq et al [14].

A Journal discussed by *Muhammad Ateeq, Hina Habib, Adnan Umer* and *Muzammil Ul Rehman*; referenced a paper from *Milbrandt Journal* ‘Using problem solving to teach a programming language in computer studies [14].

Milbrandt claims that:

The “basic features ...” of a program “include ease of learning, structured design, wide applicability, power, simple syntax, easy I/O handling, meaningful keywords and immediate feedback”. Furthermore, the journal discussed by Muhammed Ateeg et al. debate that the programming language “Python” may be considered as an alternative language to C++. ‘Python’ is a “High-level interpreted language”. Muhammed Ateeg et al. are convinced that “Python offers a clean and more intuitive syntax compared to other contemporary competitive languages for the purpose, like C++ and Java”. They also believe that due to Python’s “dynamically typed” configuration “a novice...” is able “to focus problem solving rather than language”.

Although ‘Python’ may come across as a more simplistic and user-friendly program for beginners to start off; C++ provides ‘performance’ over ‘simplicity’. In contrast, all programming languages need brain time before becoming ‘mastered’ – simplicity however is down to knowledge of the program. The performance would be a major factor in choosing a language. C++ over Python would be considered in this project.

2.5.1 PHP

PHP is a ‘server-side scripting language’ used for web development but also used as a general-purpose programming language [15].



Figure 5: Dynamic web page: example of server-side scripting (PHP and MySQL). [16]

Based on the legitimate Php website they promote this programming language by stating that Php can do *"anything any other CGI program can do"* these tools involve *"collect form data, generate dynamic page content"* and *"send and receive cookies"*. All these characteristics and *"much more"*.

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
  <head>
    <title>Example</title>
  </head>
  <body>

    <?php
      echo "Hi, I'm a PHP script!";
    ?>

  </body>
</html>
```

Figure 6: What is PHP? [15]

The programming language appeals to and persuades new beginners and current students. The words *"extremely simple for a newcomer, but offers many advanced features for a professional programmer"* were used to describe this *"hypertext pre-processor"* [17].

What makes Php a contender for the project proposed is the fact that it is 1) Open sourced. 2) Compatible with all major operating systems (OS) and Web Browsers. 3) Procedural programming or object oriented programming (OOP) discussed above are also compatible with Php. However, on top of all of these features; the major attribute would be the support of database design - Using 'MySQL' and 'PhpMyAdmin'.

2.5.2 PhpMyAdmin and MySQL

PhpMyAdmin is an open source software management tool that works with MySQL by administrating instructions over a web page. Frequently used for “managing databases, tables, columns, relations, indexes, users” and “permissions” [18] with SQL procedures.

With the hypertext pre-processor language linking up with both PhpMyAdmin and SQL operations; the proposed web based application can be implemented with loggings (Username and Passwords), information concerning Internet settings such as IP Address and MAC Address of a light can be stored in a PhpMyAdmin and called using the command <?Php -----?>.

All data stored on the PhpMyAdmin ‘web server cache’ can be called at any time – reducing delay time and increasing performance when processing data to the website.

2.6 Products to Control your Lighting

June 2015, *Jacob Kastrenakes* views the first ‘HomeKit’ products [19]. The paper focuses on the ‘Lutron’s Caséta Lighting Starter Kit’... and ‘Insteon’s’... ‘HomeKit hub’. Kastrenakes discusses the particular products that links with Apple HomeKit – *A ‘new smart home system that Apple has built into iOS’*

“HomeKit allows any product branded with its seal approval to be controlled by Siri. Those products can also be controlled by apps, even apps made by other companies”.

The idea of the HomeKit makes more complication as to connecting the product to the app. Reasons for this is due to the fact it uses a “smart home” hub for connection. The idea is; rather than having your phone directly control a connected light, your phone is actually controlling a hub which is then controlling the light.

Understandable the products discussed will be suitable for people who have purchased Lutron *Caséta* and *Insteon* products previous to this.

Kastrenakes revealed that there are still some “kinks in the system” which was the heading for his argument. He believed that the setting up of the app for the Lutron was easy and it worked with Siri on the Apple Phone when asked to turn on and off a light in his room. However, the Insteon product didn’t go as smoothly.

“The hub connected over HomeKit just fine, but the dimmers use Insteon’s own system, which clearly still has some bugs — they basically didn’t work at all. After much failed troubleshooting, I ended up with the hub unable to reconnect to HomeKit; it also broke the Siri integration that I had set up through Lutron”.

To review the Insteon product was not effective and for £39.99 on amazon [20] and a 1-star review from a single customer does match the reaction from *Kastrenakes*.

Moreover, a new product released by Philips called ‘Hue’ has recently being talked about to provide wireless control of your lighting in your household [21]. Features such as the “geo-fencing technology” allows your lights to “welcome you home...” or “switch off automatically when you leave your home”. Philips promoting the idea of “simplifying your life” and making your life “smart”. Recently, Philips have teamed up with Apple HomeKit which allows for Siri interactions, making your life a lot smarter and effective. Apple HomeKit supports “hardware authentication” and link with other possible HomeKit enabled devices for compatibility.

Price range for the Philips hue bridge compatible with Apple HomeKit and three light bulbs is an astonishing £149.95 on amazon [22] which is the cheapest compared to John Lewis and Curry’s PCWorld. The bridge must be HomeKit enabled in order to link Siri interaction and other HomeKit enabled devices. With the bridge you are able to add 50 Philips Hue light bulbs which are priced at £14.99 each on amazon.co.uk [23].

Was it a good product? Reviews from amazon showed that the majority did find it effective and would recommend the product. One customer explaining his reaction:

"In short, I'm really impressed with the regular light output (they default to that - a warm sort of '60w equivalent' white - if you just switch them on in the normal way) and colour functionality of the bulbs (which you can set up using a smartphone/tablet-based app) ... and the Bridge looks smart-but-simple and is delightfully easy to set up and use".

However, one review was not so satisfied and found a potential fault with the product. The customer giving a 1-star review described the problem below:

"At first I thought these were great. But then I realised that if you turn off your lights at the wall switch they lose their settings when you turn them back on. So if you've got all your lights set up just how you like them (which is exactly the point of these things) and someone flicks the light switch then its game over and back to full-brightness white light then they come back on"

Something which should be addressed by Philips especially with the enormous price tag which has to be initially made before receiving the product.

This product and the HomeKit has given me reassurance that the project and prototype thought-of will target audience who are not looking to spend major amounts of money and in fact can teach multi-national organisations such as Philips to lower their price margins and appeal to a broader audience. Inspiration is needed to help people understand connectivity in and around their lives and to help those persons benefit and be exciting about innovation in technology.

2.7 Cheap Products to Inspire.

The raspberry pi initially thought of in design of this proposed prototype, released a new updated product for £4 this month a review from the Independent discussed the product's capabilities and effectiveness considering the cost of £4 causing the stock of all raspberry pi Zero to be sold out and selected retails around the UK. *Andrew Griffin*, produced an article on this news. The title "*£4 computer has completely sold out, less than a day after it was released*". [24]



Figure 7: Raspberry Pi Zero, Google [25]

2.8 Usability Importance

A Journal Discussed by *Seth Earley*, discusses the importance of usability for 'Internal Systems' *Earley* explains in his introduction that businesses; especially those that are in IT should "*paying close attention to elements that make internal systems and applications intuitive and easy to use*" [26]. *Seth* also continued by explaining that, "*for the ones left behind...*" in organizations not making sure usability is top of their list of criteria may fail "*to measure up can mean lost opportunities and market share or, in more extreme circumstances, it can lead to irrelevance in the eyes of customers*" – with the customer disinterested, your project might need to be re-thought. Back to the drawing board for some.

The main point that *Earley* is supporting is – the difference between ‘usability’ and ‘user experience’? They somewhat differentiate our view on a particular problem such as Usability Issues.

The user experience involves what the “*user sees, feels, and thinks*” about a certain object. However, usability is more down to the “mechanics” of an object – You need to be asking the right questions to trigger usability issues. Can clients find information that is relevant and suited? Is the information readable? You might need to look into usability concerns for disadvantage persons who may be impaired? Another path to look down is for persons who may have a poor Internet connectivity – Can they render an image(s) on your website?

2.8.1 Measuring Usability

Finding out what the customer want should be the easiest task; although you may come across some problems that may distance your genuine data from the rest. For instance, “Fred” is younger man, well-involved with emerging technology and is involved with IT daily for work and leisure. “Fred” may have a different view on how a website may work compared to “Wendy” who is an older woman who is retired and does not immerse herself in technology often. “Wendy” may have trouble find a certain article based on her background knowledge of technology; and “Fred” may be too experienced and finds that the interactions and links could be more useful to attract a more knowledgeable IT audience.

It can be difficult but *Earley* suggests that the key to measuring usability “*is selecting the correct demographic for a user group*”. Think carefully as to what audience you are persuading? With that said, if you figure out what group you are advertising too; you can look at how to potentially attract other groups – visually impaired, persons with bad Internet connection etc.

2.8.2 User Experience

User experience is about what the “*user sees, feels, and thinks*” – this means going out of your way to find out what the user’ expectations are. The use of surveys/questionnaires would be use to find this information for primary research into a chosen topic.

From what the user expects by experiencing is what initially gives the response of the user. Steps you should under-go when asking the user for feedback:

- Establish requirements
- Evaluate the customer’ needs (How important is this factor?)
- List the FPC (Final Product Control) characteristics (Do they meet the requirements and the customer’ needs?)
- Develop a relationship matrix – Customers’ Requirements and Product Control.
- Is the problem solved from the product you have created (was it worth it? Has it improved the situation?)
- Design the correlation matrix – QFD diagram.

Customer Requirements	Customer Weights	Engineering Metrics							
		Airflow	Air Temperature	Balance (Torque)	Weight	Size	dB Level	Power Consumption	# of Switch Settings
Dries Quickly	9	9	9						
Operates Safely	3	1	9	3			1		
Comfortable to Hold	9		3	9	9	3			
Quiet	3	3					9		
Reliable	3	1	1				1		
Attractive	3							9	
Cheap to Operate	3								
Portable	1				9	9			3
Operates Easily	1		3	3					
Raw Score		96	138	93	93	36	33	27	3
Relative Weight		18%	27%	18%	18%	7%	6%	5%	1%

Figure 8: QFD diagram, Google [27]

2.9 Methodology

This project will require a waterfall model method to design and create the proposed project. A book written by *P Weaver* [28, pp. 56-57] discusses the importance of this method:

"On student developments the waterfall model may provide a good starting point..."
He also goes on to say "the model can be used for inexperienced practitioners, such as students".

A Structured System Analysis and Design Method or (SSADM) will be used to support the waterfall model. These stages are shown below: [28, p. 67]

- *Feasibility*
- *Requirements analysis*
- *Requirement Specification*
- *Logical System Specification*
- *Physical Design*

A Case Study Methodology will be promoted throughout this project, the investigation will take place to find out if a light can be turned on and off remotely via an Internet connection and with a use of a raspberry pie (sandwiched together with some electronic appliances). The testing of the product will be the turning point, for which to further the project and to sell it on or to scrap it for its poor effectiveness on households and persons lives.

The use of a survey will also be designed to query the people of Swansea. Quantitative data will be converted into data which can be analysed and incorporated into the final conclusion of the report. In plain English, the public of Swansea' thoughts on emerging technology and their current situation involving technology will be analysed and discussed, to find out if this project is needed or whether it could be a wasted solution if taken further [28, pp. 104-105] a Phenomenology method will be used also. This is a starting point for collecting meaningful data from the public of Swansea. In contrast, a deductive approach method will also be applied to this scenario; reason being, vigorous testing of this

prototype will be applied and used in simulation to see if it would be beneficial for use in a particular household.

2.10 Conclusion

From this chapter, we've learnt about the Internet of Everything and how globally the world should be heading towards the IoE. We have also learnt that mobile data is at the for-front of the IoE with the next generation of mobile data thriving to improve the way we roam and communicate through our network device with increasing convergence time. We have also discussed the products out there that involve remotely controlling of a light and how more recently developers have come up with advanced ways to control a light from a web-based application such as Php. Moving on, we found vital components needed to create a product to remotely control a light via a web-based application. We compared an arduino and a raspberry pi for the hardware component needed to converge with the light. With that we discussed the tools needed for use of a raspberry pi such as the Linux OS, and Apache and how it is compatible with MySQL and Php programming language.

In more detail we discussed what programming language was viable when programming the websites html – comparing the Python and C++. In more detail, we also discussed Php and why it is essential for the prototype proposed. Compared to the proposed prototype we looked further into other brands that have made products to control your lighting such as Philips, analysing the quality of service it has for the high price tag; does the product actually work effectively? Looking at the cheaper end value of a product such as the raspberry pi zero to inspire end user's to buy, create and play with emerging technology and improve

connectivity in our lives. Finally, the usability importance and user expectation was discussed to analysis the need for usability and to understand the point of listening to user requirements in order to make a product successful.

The next step in this report is to look at the method of collecting data – the research methodology.

Chapter 3 - Research Methodology

3.1 Introduction

This section involves in depth analysis of the research method chosen to carry out a product design task. Based on research the waterfall method was elected; such topics include the feasibility study (method of which to carry out a task), requirement analyses and specification (what the end user wants? or what it should require?), system specification (what the system should do?) and finally the physical design (what the prototype will look like?) – This covers the web-based application and the physical hardware components converging together.

The above chapter has focused on the method of which to carry out a task and has revealed the need for the project and the motivation behind this idea; the following will look into the requirement specifications (non-functional and functional), system specification (proposed system), business process model notation diagram, cost-benefit analysis (tangible or intangible) and the alternative solutions.

3.2 Requirement Specifications

What must the proposed system provide for the users? The system should allow users to turn off their lights in their household over the Internet. The user should receive instructions on how to operate the product from the website to the behind software run by php, MySQL and Linux apache to reassure the user's queries in a user guide. The user should be satisfied with the product and the concept of making a household compliant remote and equipped for the Internet of Everything. It must be reliable and relevant to offer the user reassurance when using the system. For this system to actually work the data which is inputted into the application must be accurate and correct otherwise the system will be unreliable and untrustworthy for the user. It must be user-friendly for all to allow users of all ages and computer know how to benefit from the system. It must cover all accessibility issues such as

colour schemes and screen resolution on the app so that everyone including people with short term and long term disabilities to access the system and profit from it.

The functions of the system; the user must have an Internet Service Provider (Broadband Connection) including a smartphone which is connected to a reliable network in their particular area. A user must own a household and a light to benefit from this product.

What are the constraints of the new system? Building the database system and migrating it into a user's home could cost sufficiently due to security concerns and restrictions. Ease of use? Could be questioned due to the fact that it is a bespoke system, if a user has a problem, it won't be able to find information online on how to solve it. The User Response times need to be addressed, could become very costly.

Security:

The app must provide relevant, reliable and trustworthy information whilst keeping the data secured and keeping the integrity of the information inputted onto the database and the app. Therefore, the user must require an updated antivirus system on their home computer and smartphone as well as Username and Passwords which be implemented throughout the system with adequate validation to prevent brute-force attacks. Backing up of data is important for this software to be reliable and beneficial and will be addressed throughout the system.

What Data needed protecting? Users may wish to have their PhpMyAdmin information protected and the Username and Password which allows entrance to the system app. Restrictions? The user should be the only one to access the information on the database and system app.

Service availability:

24/7 access around the World. VPN server must be available for over the Internet connection; otherwise local is fine.

3.3 System Requirements

The proposed system will have to run accordingly. The user wishing to test this product will need to have the following equipment:

- A Light (with a working bulb)
- The recommended files which will cover the Arduino software, Raspberry Pi OS for the GUI, PhpMyAdmin software, newest version of Php and Linux Apache all which will be explained in a Use Guide found online.
- Hardware components such as the Arduino board, relay module transistor, wires, jumpers, breadboard and the raspberry pi with the additional software for the both to be coded.
- An Internet connection is recommended and Wi-Fi enabled to connect to the Raspberry Pi over the Internet.

The user with the required equipment above will visit a website to find a user guide.pdf. Once opened, the user will get in depth walk-through on how to build the product from the hardware purchased to setting up the circuit; to then coding the Arduino and Pi with relevant UNIX commands to download and apply the software. The user guide will focus its intentions to enabling the user has used good practice techniques with useful tips to ensure reliable information is available and the end product is successful for the user. With the final cabling completed and the files downloaded; the user may open the website welcome page following the links to the homepage and start turning their light on and off.

3.4 Research Process

This section involves the methodologies discussed to evaluate and analyse the major topics of research in this paper. Also, the paradigms used to promote a phenomenology or a positivism approach and take a triangulate overall design of the paper.

3.5 Research Philosophy

The research philosophy is one which is taken serious as it concisely underpins the project as a whole. Based on the project both positivism and phenomenology will be covered. For instance, the real approach to the project will be to look at what the public of Swansea feel about a new innovative project (which is for the end users best interest). Surveys and Questionnaires will be used inevitably to collect quantitative data to analyse and evaluate the project as a whole. However, the other-side of things will push the project into qualitative data from which questions arise such as; Will this benefit customer in households? Will it be a profitable product? These questions will promote a triangulate approach and therefore both paradigms will back each other research approaches to claim a joint overview of the paper.

3.6 Research Methodologies

The research methodology proposed would involve the case study methodology. The object of the case study project would be to *'investigate and evaluate how computing is being used in real-life situation'* also to study *'how a specific technology is being used in a particular situation'* [28, pp. 14-15].

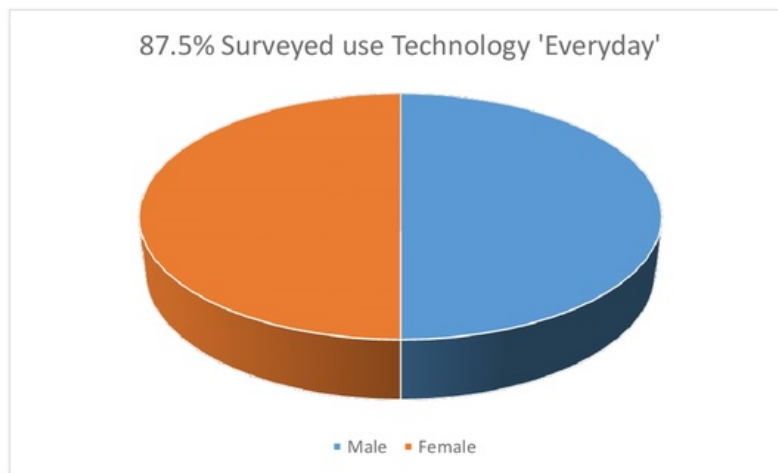
This paper to clarify investigates the topic of Internet of everything and how it is manipulated in a real world situation. The idea of Internet of Everything focuses on

topics concerning companies involve a situation to solve a problem a particular situation for instance British Gas incorporating a product called Hive discussed in chapter one of this paper to solve the problem of interacting more people and their essentials get connective over the Internet; i.e. controlling a person's heating from their smart phone.

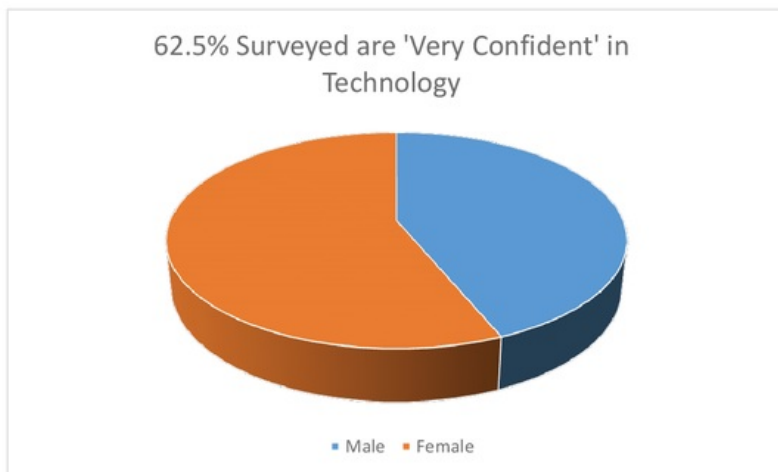
3.7 Questionnaire/Survey Results

January 21st-February 21st

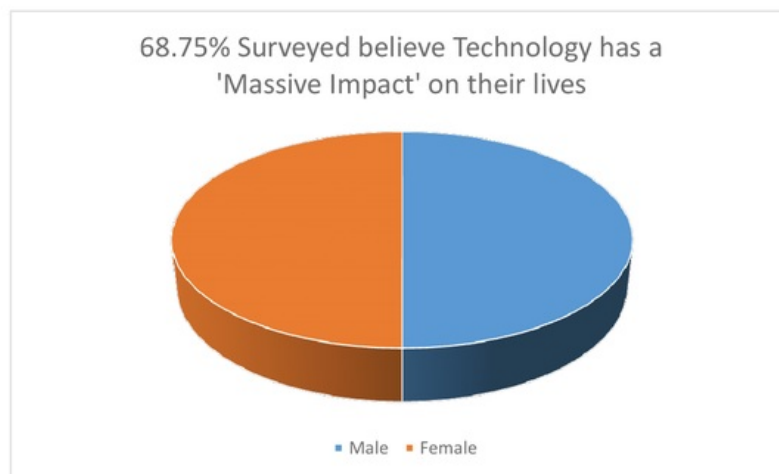
In this period of time 32 people were surveyed in Swansea to find out about the public views on emerging technology. The results are below:



From the Age groups selected (16-25, 26-40, 41-59 and 60+) all but one was chosen as using technology 'Everyday'; the group 41-59 had an incredible 57.14% statistic that do 'not' use technology 'Everyday'.

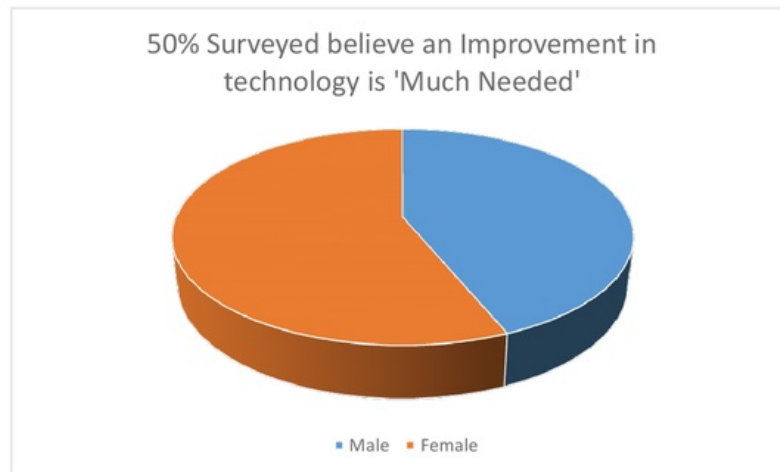


High statistics of 76.92% for 16-25 group and 80% for the 26-40 group shows the Confidence of the two categories however low figures of 28.57% for the 41-59 group and 50% for the 60+ explains that confidence is low in these age groups. Explaining why the last statistic of the 'Use of technology in their lives' is really low for the 41-59 age group.



High statistics of 100% for 60 + group and 80% for the 26-40 group shows the importance of the two categories however low figures of 53.84% for the 16-25

group and 42.85% for the 41-59 explains that technology is not as important in these age groups lives.



High statistics of 100% for 60 + group and 71.42% for the 41-59 group shows the passion of the two categories to be introduced to new and improved technology however low figures of 40% for the 26-40 group and 38.46% for the 16-25 explains the lack of belief in technology and improvement wouldn't change their opinions in these age groups.

3.8 Review of Questionnaire/Survey

The result of the survey revealed that, people aged 41-59 are believed to use technology less in their lives compared to the other age group surveyed. The reason being is that the people in that age group of 41-59 are not as confident with technology as discussed in the above analysis. Although confidence has decreased the use of technology in everyday activities for the 41-59 age group the results show that 71.42% of that group want to see an improvement in technology; to inspire and push them to use technology more in their lives.

With this in mind the project will be implemented to persuade the 41-59 age group to consider using technology in their lives and homes with a helpful user-friendly website and a practical solution to a light problem that all generations will agree is needed in the world of connectivity.

Chapter 4 – Design and Implementation

4.1 Introduction

This chapter looks to view the process of designing the prototype with all the information essential for implementation. The chapter will also focus on the specifications described in the previous chapter to target specific attributes to make the project effective and efficient for a purpose to argue.

The hardware components are the initial thought made to prepare for the design. This was organised by the University of Wales Trinity Saint David. As discussed the components needed were the Arduino, Raspberry Pi, breadboard, wires and jumpers for connecting and a relay module transistor. A light and the holder with the plug was needed and acquired at home. Below shows the hardware described above:

Figure 9:

Raspberry Pi 2.



Figure 10: Arduino Uno.

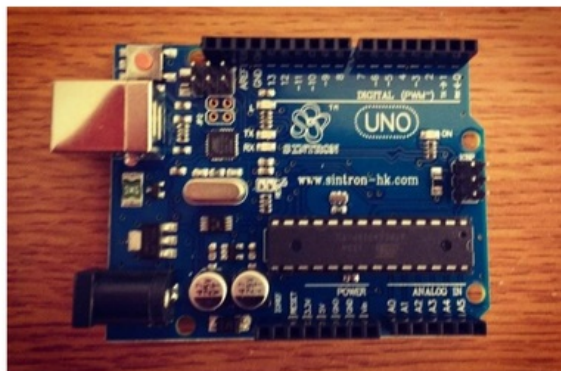


Figure 11:
Breadboard,
Wires and Jumpers.

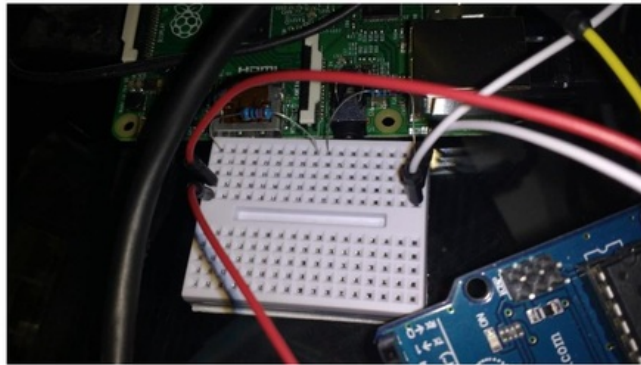


Figure 12: A Single Relay
Module Transistor.



Figure 13:
Light holder
& Plug.

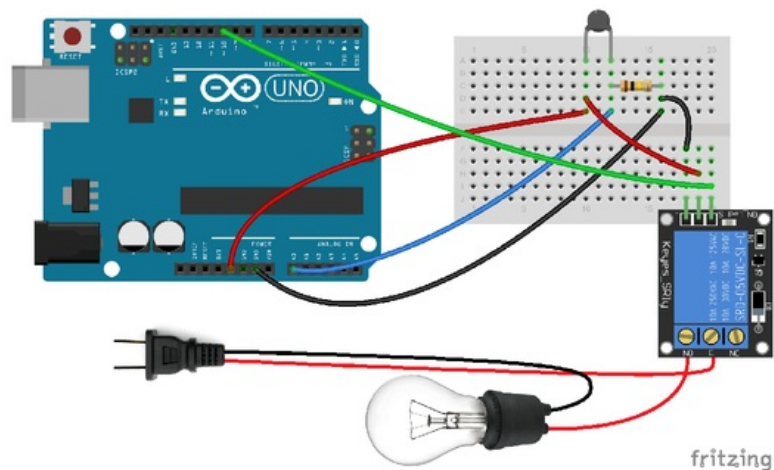


4.2 Construction of Hardware

The first step was to connect the light to the relay module transistor by cutting one wire half way and stripping the wire to expose the copper. This section was dangerous and did involve exposed wires from which volts of electricity occur through when powered on (Advice: Research into how to deal with electrical compliances and live wiring before attempting).

Understanding how to put together all of these hardware components needed research; coming across a site www.circuitbasics.com; a website specialising in walkthroughs to building circuits with Arduino's and Raspberry Pi's. Below is a diagram of the circuit which influenced mine.

Figure 14:
Circuit Basics.
[29].



Once stripped it needed to be added to the relay module. Wire attached to the light as shown above must go into either NO (Normally Opened) or NC (Normally Closed). Both connection would be correct, the NO will mean that when powered through the relay the light will turn on; and the NC will be turned off when powered on. In this case the NO was chosen. The wire attached to the plug needs to be placed in the C for Common; this will send electricity to the relay powering the relay on for the relay to then power on the light creating a looping circuit.

5V Relay Terminals and Pins

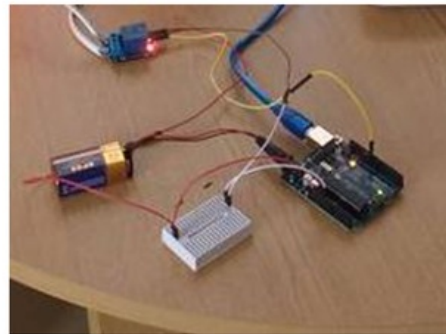


Figure 15: Circuit Basics 2 [29].

The next step was to then attach the wires and the jumpers to the Arduino from the relay with the help of a breadboard. As shown above the ground or the GND which was shown on the Arduino was wired to the negative pin on the relay or the ground shown above. The 5V on the Arduino was wired to the positive pin on the relay or the 5V Vcc shown above and the final pin will be wired to the pin which you want to control the light; in this case pin 10 was chosen and used later on for the coding on the Arduino.

Once all the wiring is complete, the circuit will be completed.

Figure 16: Completed Circuit. [29]



4.3 Coding on the Arduino.

The next stage was to code the Arduino to switch the light on via the relay module. Initially when receiving the Arduino, a cable with a USB tail end was used to link up with a laptop or raspberry pi. In this case Arduino was connected to the laptop/workstation.

Once plugged in, the Arduino software was needed to be installed on the laptop/workstation from the Arduino website (<https://www.arduino.cc/en/Main/Software>) [30].



Figure 17: Running Arduino Software [31]

The Arduino GUI appeared after running the software. The Arduino software needed to be linked up with the port that the Arduino was connected to (COM1) and the board which was the Arduino/Genuino Uno. Once set the code can be uploaded.

Next stage was to code the Arduino to turn the relay on and off thus turning the light on or off.

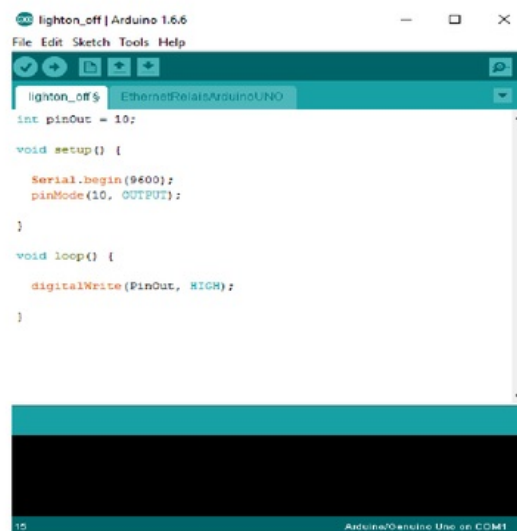


Figure 18:

Code for the Arduino.

Once entered, the code was uploaded to the Arduino; the outcome is shown below:

```
digitalWrite(PinOut, HIGH) turns the light "On"  
digitalWrite(PinOut, LOW) to turn the light "Off".
```



Figure 19:
Light On/Off.

4.4 Creating a Website

The creation of the website was the next stage. For this project a welcome page and other relevant pages have been implemented as a user-friendly GUI website application, shown below the webpages were made up of HTML for a user-friendly GUI for the user, CSS for external style sheets applied to all pages for professionalism and JavaScript to add interactivity to the webpages:

welcome.php



Dissertation_Homepage.php

Home / About This Application / Gallery

About This Application

You are logged in Log out

Table

Light ID	Light Name	Light Status	On/Off Status
0001	Light 1	---	~ON~ ~OFF~

Dissertation_About.html

Home / About This Application / Gallery

About This Application

You are logged in Log out

The Internet of Everything

The world today is full of technology with tablets and computers and various other devices. Technology has been at the forefront of applied systems and organizations for years. The world is a place of amazing efficiency and productivity in performance compared to human nature. With emerging computing devices, we humans are now able to connect with the Internet and technology provides us all with its services and productivity, leaving none of us without access to the Internet. This is the Internet of Everything.

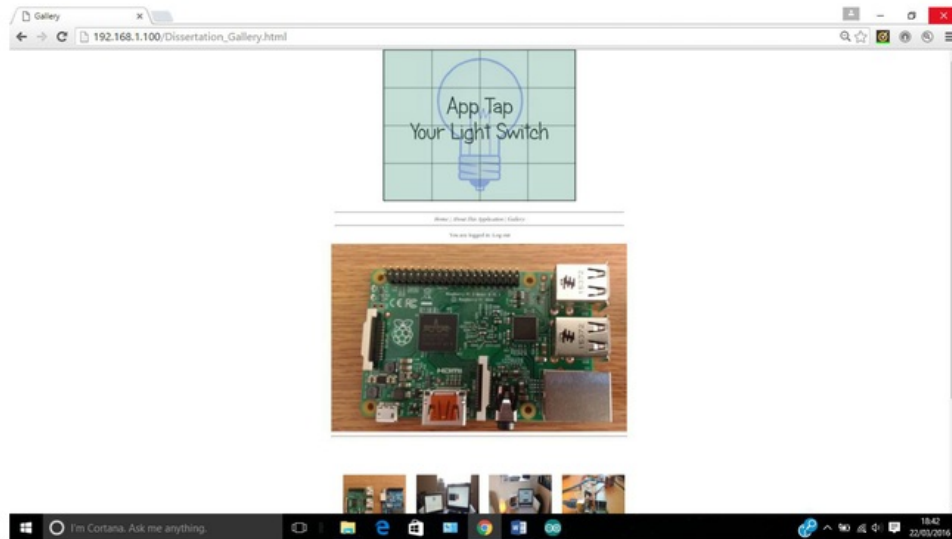
What is App Tap Your Light Switch?

App Tap Your Light Switch was designed to improve connectivity within your household. This application was developed as an experiment to prove how you can approach essential equipment in your household such as a light in this scenario and use it as a remote control, providing an alternative connectivity to a remote.

This Web-based application is designed using PHP. The programming language used here is PHP, HTML, CSS, and JavaScript. The application is used as a reference to store various data such as Usernames & Passwords for logging capabilities. The application is used as a Web Server to store all files stored on the computer.

To interact with the light, the program defines and handles the On and Off Process. First of all, a plug attached to a light bulb was designed to be placed into a relay module. The relay module was then used to connect the AC and DC circuit and allows the user to control the power to switch the light on. Using the module, the code was then uploaded to the board and the relay module which was set to pin 12 to control the light status. Connecting the module to the relay module and connecting the circuit to the relay module to turn the light on and off. Using this, the code in the code was used to connect the software with the hardware and the relay module to act as a server. Finally, the code was executed via a LAN connection through the user's computer through a LAN connection through a Virtual Private Network.

Dissertation_Gallery.html



Joinedtables.php



The main page was the Dissertation_Homepage.php. This was the page that links up with the arduino and the light.

4.5 Raspberry Pi.

Once the website was created the next stage was to connect the Arduino to the Raspberry Pi to act as a web server.

To view the GUI of the Raspberry Pi, installation of the Operating System files on the SD card was needed. The files to transfer were found on the Raspberry Pi website (<https://www.raspberrypi.org/downloads/>)[31]. For this project rasbian was installed. The Pi was at accessed first through a HDMI cable to a monitor to view the GUI eventually a SSH connection was applied and tightvncserver and client was used to access the Pi's GUI through the laptop/workstation. The Pi was able to access the Internet though a bridge connection from the Wi-Fi at home through an ethernet cable.



Figure 20: Raspberry Pi GUI.

Once able to access the GUI and upload files and software using Linux commands. Apache was needed to allow the pi to act as a web server; below was the commands

found on DigitalOcean and uploaded to the terminal of the Pi:
(<https://www.digitalocean.com/community/tutorials/how-to-install-linux-apache-mysql-php-lamp-stack-on-ubuntu>) [32]

```
sudo apt-get update --- Update
sudo apt-get install apache2 --- Apache2 download
sudo apt-get install mysql-server libapache2-mod-auth-mysql php5-
mysql --- MySQL download
sudo mysql_install_db --- MySQL activation
sudo apt-get install php5 libapache2-mod-php5 php5-mcrypt ---
PHP5 download
```

Once downloaded, the PHP test page was used to test apache2 and php5. All web pages are stored in var/www/ directory on the Pi. A file was created in TextWriter and called info.php. In the file the code below was setup:

```
<?php
    phpinfo();
?>
```

From this point it was possible to view the webpage in your browser under 'localhost' shown below:

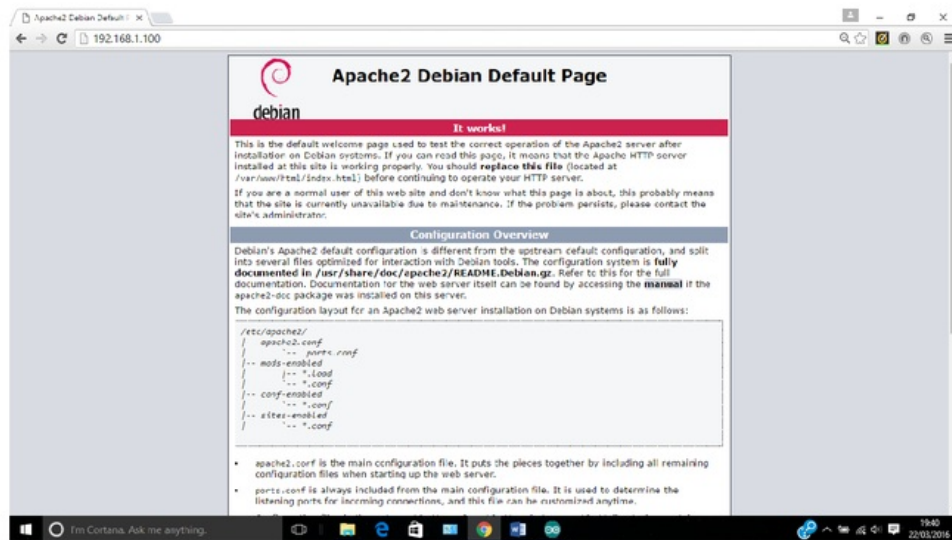


Figure 21: Apache working.

This meant apache2 was up and running.

Next stage, was to transfer all the webpages to Pi under the directory of `var/www`.

This prompted me with an error message at first not allowing to move the files. This was caused due to privileges which were changed in the terminal. `'chmod 666 /var/www'` was used to allow the transfer of files to `var/www` directory.

Below shows the outcome:

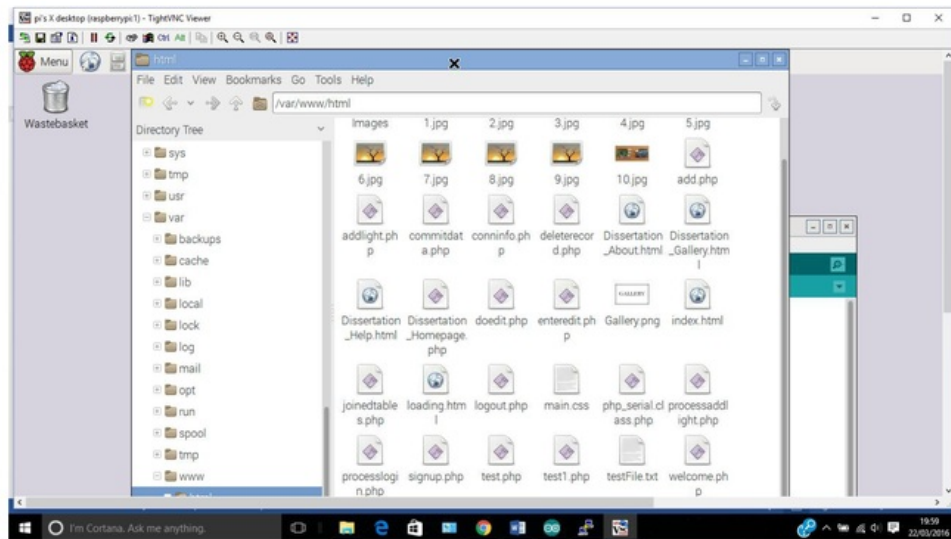


Figure 22: var/www directory.

Once done the webpages were viewed from the browser of the raspberry pi.

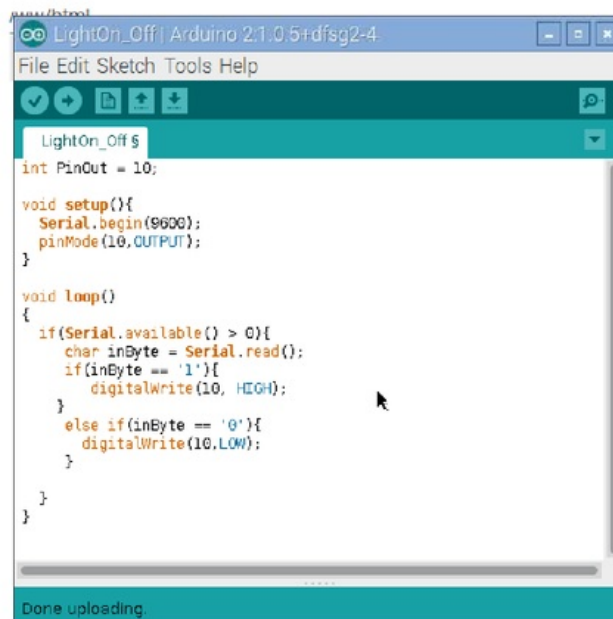
4.6 Controlling the Light from the Website (Locally)

This section involved adding the Arduino software onto the Raspberry Pi and sending data through the serial port to turn the light on or off.

The initial step was to download the software for the Arduino. ‘`sudo apt-get install arduino arduino-core`’ was used in the terminal.

Once downloaded it was opened in the GUI of the Pi by clicking on “Menu” tab and hovering over “Electronics” and clicking on “Arduino”. Similar to the setup that was discussed in 4.3 the Arduino board needed to be selected in the “Tools” Tab and the port needed to be set; only this time the ACM0 was selected for the Pi output.

The code was uploaded as shown below:



```
LightOn_Off | Arduino 2:1.0.5+dfsg2-4
File Edit Sketch Tools Help
LightOn_Off
int PinOut = 10;

void setup(){
  Serial.begin(9600);
  pinMode(10, OUTPUT);
}

void loop()
{
  if(Serial.available() > 0){
    char inByte = Serial.read();
    if(inByte == '1'){
      digitalWrite(10, HIGH);
    }
    else if(inByte == '0'){
      digitalWrite(10, LOW);
    }
  }
}

Done uploading
```

Figure 23: Arduino code.

Next stage was to add the PHP files to link the serial ports and to add the PHP extension to the homepage of the webpage (Dissertation_Homepage.php). Enclosed with the report are the two php files shown below.

- php_serial.class.php
- Dissertation_Homepage.php

Once both PHP files were uploaded to the var/www directory on the Pi, the last stage was to allow permission of the port ACM0. The commands below allowed this:

```
ls -l /dev/ttyACM0
chmod 666 /dev/ttyUSB0
```

Once these commands were made in the terminal, it was possible to turn a light on and off from the hyperlinks on the webpage locally from the 192.168.1.100 (Pi's address) or (localhost from the Pi).

4.7 Controlling the Light from the Website (Over the Internet)

A VPN method was chosen to access the Pi over the Internet.

VPN is a Virtual Private Network setup. Weaved.com was used to act as a VPN and is used to *"Manage Network Devices from Anywhere"* [33]. Signing up (www.weaved.com) was free and with a single account set up, it was possible to connect up to five services on a single device. In this project, two were needed for the Raspberry Pi; HTTP to view the website and SSH to log into the Pi's terminal. Below were the commands used to add both services and link it up with the Pi:

```
sudo apt-get update --- Update
sudo apt-get install weavedconnectd --- Weaved download
```

First stage was to sign up and create an account. Once done, the command below was entered to install weaved on the Pi:

```
sudo weavedinstaller
```

A prompt message in terminal then asks for the email and password to the weaved account that was previously set up.

When successful, the next prompt message appeared to select the services, shown below:

```
=====
Protocol      Port      Service      Weaved Name
=====

***** Protocol Selection Menu *****
*
* 1) SSH on default port 22              *
* 2) Web (HTTP) on default port 80       *
* 3) VNC on default port 5901            *
* 4) Custom (TCP)                       *
* 5) Return to previous menu             *
*
*****

Please select from the above options (1-5):
█
```

Figure 24: Weaved installation.

Selecting “1” and accepting the default port 22 as the port number gave another prompt message to save the device name (Raspberry-Pi-SSH).

Once SSH was configured the HTTP was next; selecting “2” and accepting the default port as 80 gave a simpler prompt message to save the device name again (Raspberry-Pi-HTTP).

Once done, the weaved account was set up and providing the Pi was on and connected to an Internet connection it was then possible to access the website from a remote location.

Logging onto weaved and the account created previously showed the services setup:

New Service Plans Available

Go to [My Account](#) to choose a new service plan.

Your current list of services

Click on service names to connect. Your account allows for 10 registered services and 30 minute connections on up to 1 concurrent service(s). You can [Upgrade Now](#) to get more services, longer connection times and more concurrent connections.

Name	Type	Status	
Raspberry-Pi-HTTP	HTTP	online	Share Settings
Raspberry-Pi-SSH	SSH	online	Share Settings

Figure 25: Weaved Services.

Clicking on the device name set (Raspberry-Pi-HTTP) weaved.com then attempted to contact the raspberry pi over the Internet to find the external address from which the website can then be accessed.

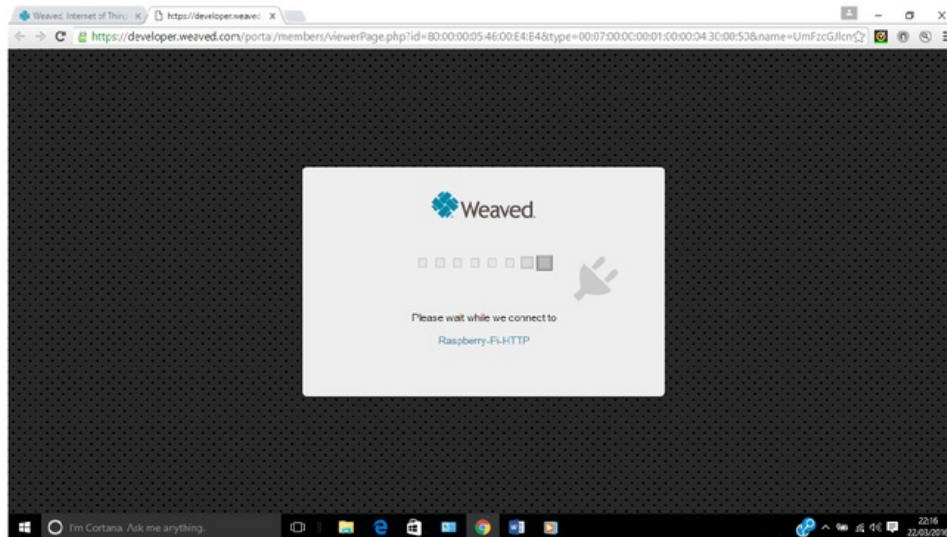


Figure 26: Weaved Connecting to Pi.

Successful the default info.php page showed set up previously to test apache2. The websites stored in var/www on the Pi were accessible via weaved.com.



Figure 27: Connection over the Internet.

Chapter 5 – Product Evaluation

5.1 Introduction

This chapter looks review the design and implementation process and to evaluate if the product meets the aims and objective discussed in the first chapter and if the final design meets the specifications in chapter three to give an overall conclusion on whether the time spent researching and planning has been worthwhile to pitch to the world of users and technology.

5.2 Meeting the Aims and Objectives

"The project aim is to develop a web-based application using php that can be used adjacently with a programmed raspberry pi and some electronic appliances (a relay, microcontroller and a light) to turn a lights state to on or off".

The project aim matches the final product. The project has shown that it has implemented the website-based application stored on the Pi; from which the Arduino is connected and controls the light state based on the hyperlink on the webpage.

The aim does not specify changing the light state over the Internet but due to the title of 'Internet of Everything' it was taken upon to implement over the Internet activity to present a valid argument about the lack of connectivity in and around the world.

5.3 Meeting the Specifications

Below shows the “Should” and “Must” specifications:

SHOULD	MUST
The system should allow users to turn off their lights in their household over the Internet.	It must be reliable and relevant to offer the user reassurance when using the system.
The user should receive instructions on how to operate the product from the website to the behind software run by php, MySQL and Linux apache to reassure the user’s queries in a user guide.	It must be user-friendly for all to allow users of all ages and computer know how to benefit from the system.
The user should be satisfied with the product and the concept of making a household compliant remote and equipped for the Internet of Everything.	It must cover all accessibility issues such as colour schemes and screen resolution on the app so that everyone including people with short term and long term disabilities to access the system and profit from it.

Overall, all of the specifications have been met. The ‘Must’ specifications were initially met first and the ‘Should’ were looked at afterwards.

The website needed to meet the user-friendly graphical user interface and was met by looking into usability issues discussed in chapter 2. The website needed to be compatible with all devices such as tablets, mobiles and laptops this meant looking into developer tools on all browsers to ensure the webpages are accessible and user-friendly. Colour schemes were discussed prior to the design of the webpages in chapter 4 to understand the trouble-some users have with colour and text. This research approach, was incorporated onto the webpages to leave the background white and black text. Few images were applied to reduce rendering time for connection issues that some users may have due to broadband limits and constraints.

With the fact that the light can be switched on and off via the website remotely over the Internet the project can be confirmed as “reliable and relevant”.

Due to the fact that the product has not been trialled and tested by the public the specification of user satisfaction is not evaluated. For future production, a question/survey will be needed to ask the people of Swansea their opinion on the website and the light to get an in depth report on what the user satisfaction rate will be.

5.4 Conclusion

Overall, the design and implementation stage has successfully met the specification set in chapter one and chapter three. The process of turning the light on and off from a website remotely over the Internet works accordingly. The next process for future recommendations would be to trial and question users on the design and to ask if this would be worth implementing technology into their lives and homes. The last process would be to create a pdf file and user guide to encourage users to implement this product into their lives and homes.

Chapter 6 – Conclusion

6.1 Introduction

This chapter looks at concluding the paper as a whole and evaluating the purpose of the paper to understand the importance of the development of the product “App Tap Your Light Switch” and the reason for incorporating this in the world of ‘Internet of Everything’.

6.2 App Tap Your Light Switch

The premise of the paper is to encourage the world to move onto the next stage of the world of Internet and connectivity; with this in mind the design and implementation focused time on persuading people to understand practical problems in homes from compliances such as a simple light to other essentials such as the heating discussed in chapter two with British Gas and ‘Hive’. This experiment set out needed the research into previous plans organisations are doing to improve the connectivity in our homes; which viewed the constraints of implementing such technologies. ‘Philips Hue’ was discussed in chapter two as a technology to help improve connectivity of household lights, however the price of product was a disadvantage for anyone wishing to improve their connectivity. Also the result of the Questionnaire that was used to find the views the public of Swansea have on ‘Emerging Technology’ revealed that people aged between 41-59 are believed to use technology less in their lives compared to the other age group surveyed. The reason being is that the people in that age group of 41-59 are not as confident with technology as discussed in chapter three. Although confidence has decreased the use of technology in everyday activities for the 41-59 age group the results show that 71.42% of that group want to see an improvement in technology; to inspire and push them to use technology more in their lives. This analysis allowing to seek out the target audience of the product; a person wishing to learn more about technology and connecting compliances to the Internet at home and whom wishes

to learn how to code and wire a circuit for a cheap price. The product encourages this and for those who do not have the knowledge it is easy to understand and implement into their homes. The paper focused its thoughts to evaluating how to make this a viable product, with usability issues explaining good practice that will eventually be applied to the product.

The overall product and the specifications have improved the constraints of cost and user-friendliness of all technologies out there to improve the world of Internet of Things and with successful testing and evaluation in chapter four and five the product is viable.

This paper has introduced a new way of connectivity and design to inspire the world to move into the next stage of Internet. With the product offering a new, cheap and practical approach to connecting household lights to the Internet; whilst also giving the people whom views are against improvement with technology an alternative solution to problems in and around the house and therefore encouraging the world and the concept of connectivity to move forward into the world of Internet of Everything.

6.3 Future Recommendations

For future work, a user guide would be needed to introduce the projects practical side with helpful images and tips to turn a user's household light into a remote light which can be turned off via a website-application. To help with notifying the user of the lights state an email or text alert could be applied to inform the user the light is on or off. A helpful colour scheme on the website to show if the light is on (green) or off (red) would be an additional design and offering more awareness to the user.

6.4 Final Thoughts

It is clear to me that the world of Internet is ready to move on; however, the world is unsure of how to go about implementing and using this in everyday lives for beneficial perks rather than allowing assumptions to be made over technology becoming a waste of time and money. Through surveying and querying it is possible to understand the possible reasons for not using connectivity in and around lives. Not having a clear understanding into technology and how it can benefit everyone is needed; simple seminars and groups need to be formed to encourage all generations on how to use technology and therefore persuaded into using it to better the world of Internet and themselves. The light project thought of went extremely well and personally has bettered my ability in coding webpages through understanding of html, css and JavaScript whilst learning how php can influence potential projects such as mine. It has also encouraged me as a personal to deal with practical problems such as stripping of wires and connecting hardware components to act as one circuit through little knowledge at the start. Through little experience, this process has taught me that you don't need to have a good understand in a subject to succeed; just the correct mentality, work ethic and enthusiasm is needed to find a solution to a problem.

I believe that the overall product could be improved with more time available. The website still needs to show when the light is on or off. To improve this a simple email or text alert is needed to alert the user of the light state. If this product is to inspire users to control their lights at home; a solution would be to create a dummies guide to controlling their lights with step by step tutorials with all files needed for the Raspberry Pi and Arduino with the sample code for the websites.

Overall, within the time scale the product is a success and completes the project aim *'to develop a web-based application using php that can be used adjacently with a programmed raspberry pi and some electronic appliances (a relay, microcontroller and a light) to turn a lights state to on or off'*.

Chapter 7 – References and Appendix.

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7.2 Appendix

7.2.1 Questionnaire/Survey



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Student: **Rhys Howells**
Studying: **Computer Networks** at University
of Wales Trinity Saint David Swansea
Email: **rhys2009@hotmail.co.uk**



What is this Survey For?

This survey is designed to help evaluate my personal studies based on my degree in Computer Networks. Ideally, this will help me to understand the thoughts and feelings the public of Swansea have on emerging technology. All information will be taken in strict confidants and all data collected will be used only for research. Data will not be passed on to any 3rd party representatives.

General Questions

1. Gender

☐ Male ☐ Female

2. Age

☐ 16 - 25 ☐ 26 – 40 ☐ 41 - 59
☐ 60 +

3. Job Status

☐ Part-Time ☐ Full-Time ☐ No Employment

4. Where do you live currently?

☐ South West Wales ☐ North East Wales ☐ South
East Wales
☐ North West Wales ☐ Other _____ Please
Specify.

5. Housing

☐ Flat ☐ House ☐ Student Accommodation
☐ Complex ☐ Other _____
Please Specify.

NOTE: In this section please tick the box that meets your ability to perform a particular task or problem based on the questions given. Please only tick one box. If not sure, tick the number 4. ☒.

Emerging Technology

How often would you use 'technology'?

1. Never ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ ☐ 7. Everyday

How confident are you with 'technology'?

1. Not ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ ☐ 7. Very
Confident Confident

Is 'technology' an important factor in your life?

1. No ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ ☐ 7. Massive
Impact Impact

Would you like to see an improvement in technology in and around your 'household'?

1. Not ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ ☐ 7. Much
Needed Needed

Thank you for completing this survey.

If you have any additional information to give that may support my research;
please provide this on the lines below. Once again; thank you for your support.

7.2.2 Questionnaire/Survey Results

		M	F	Age	Job	Location	Housing	Often Use Technology?	Confidence in technology?	Importance of technology?	Thoughts on Improvements in technology?	Additional Information
	x			26-40	FT	SEW	Flat	7	7	7	5	
			x	16-25	PT	SWW	Flat	7	7	7	5	
	x			16-25	PT	SWW	House	7	7	7	6	
			x	41-59	PT	SWW	House	7	5	6	7	
	x			16-25	PT	SWW	House	7	6	6	5	
			x	26-40	PT	SWW	House	7	6	6	4	
			x	16-25	PT	SWW	House	7	6	5	5	
			x	16-	PT	SWW	Student	7	7	7	7	

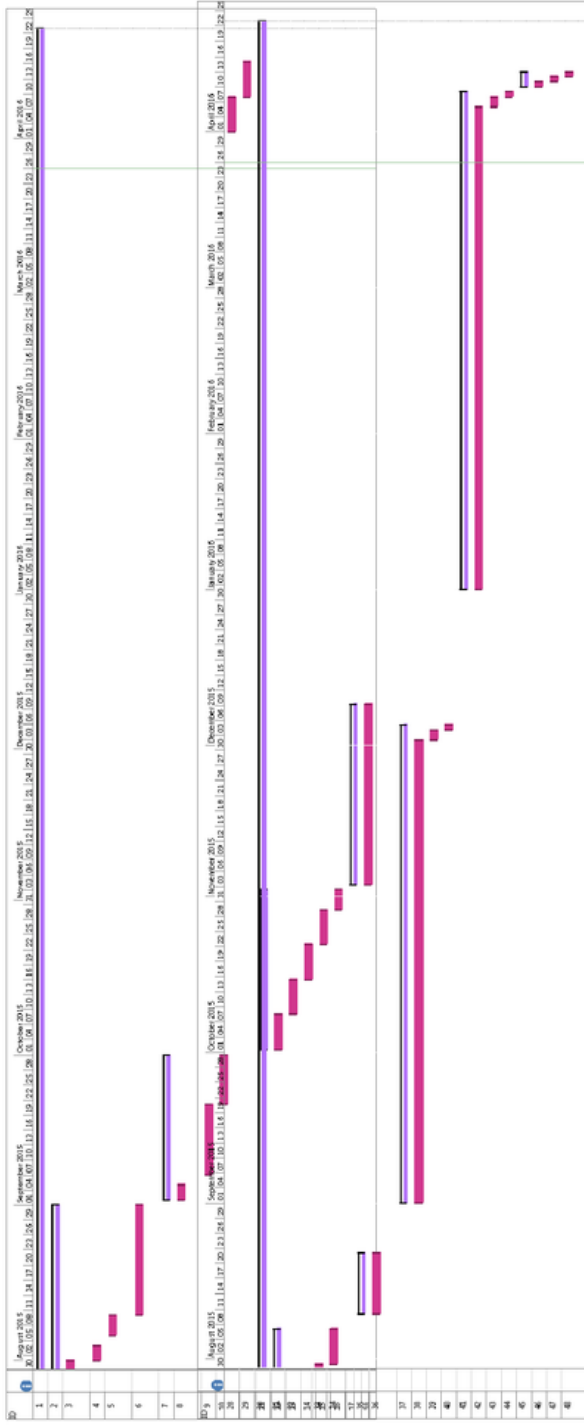
7.2.3 Time Management Schedule

Task Mode	Task Name	Duration	Start	Finish
Manually Scheduled	Dissertation Paper	214 days	Wed 01/07/15	Fri 22/04/16
Manually Scheduled	Research & Reading	44 days	Wed 01/07/15	Mon 31/08/15
Manually Scheduled	Identify Suitable & Manageable Topic	23 days	Wed 01/07/15	Fri 31/07/15
Manually Scheduled	Mind Map	2 days	Sat 01/08/15	Mon 03/08/15
Manually Scheduled	Create a Gantt Chart in Microsoft Project	3 days	Thu 06/08/15	Sun 09/08/15
Manually Scheduled	Under-go the Research into the Topic	16 days	Mon 10/08/15	Mon 31/08/15
Manually Scheduled	Expand Research	21 days	Wed 02/09/15	Wed 30/09/15
Manually Scheduled	Questionnaire & Survey (Swansea)	3 days	Wed 02/09/15	Fri 04/09/15
Manually Scheduled	Gather Data: Report	11 days	Mon 07/09/15	Sun 20/09/15
Manually Scheduled	Mind Map Additional Data from Questionnaires & Surveys	8 days	Mon 21/09/15	Wed 30/09/15
Manually Scheduled	Chapter 1: Introduction	22 days	Fri 02/10/15	Mon 02/11/15
Manually Scheduled	Abstract & Background	1 week	Fri 02/10/15	Thu 08/10/15

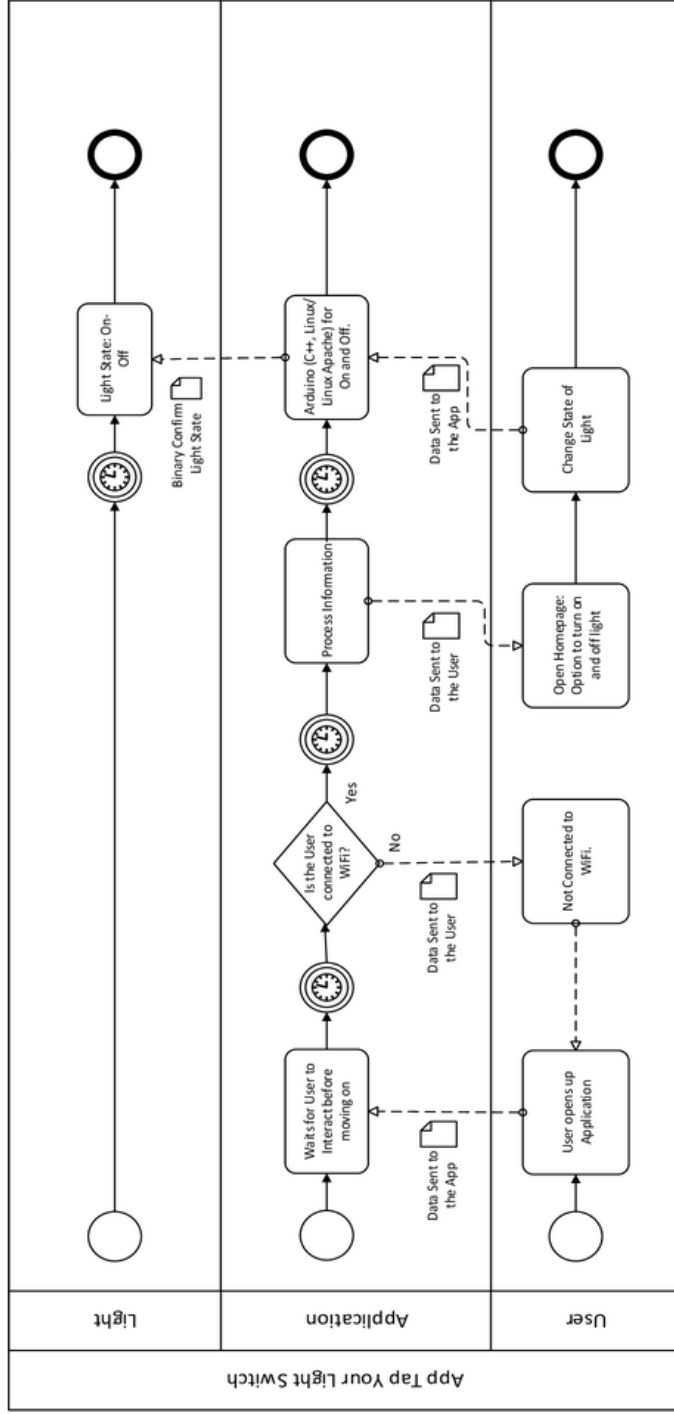
Manually Scheduled	Motivation	1 week	Fri 09/10/15	Thu 15/10/15
Manually Scheduled	Hypothesis	1 week	Fri 16/10/15	Thu 22/10/15
Manually Scheduled	Research Approach	1 week	Fri 23/10/15	Thu 29/10/15
Manually Scheduled	Outline of Dissertation	2 days	Fri 30/10/15	Mon 02/11/15
Manually Scheduled	Chapter 2: Initial Writing	26 days	Wed 04/11/15	Wed 09/12/15
Manually Scheduled	N/A	26 days	Wed 04/11/15	Wed 09/12/15
Manually Scheduled	Chapter 3: Detailed Writing	30 days	Mon 30/11/15	Fri 08/01/16
Manually Scheduled	N/A	30 days	Mon 30/11/15	Fri 08/01/16
Manually Scheduled	Chapter 4: Gathering Facts	27 days	Sun 10/01/16	Mon 15/02/16
Auto Scheduled	N/A	27 days	Sun 10/01/16	Mon 15/02/16
Manually Scheduled	Chapter 5: Conclude	20 days	Sat 20/02/16	Thu 17/03/16
Manually Scheduled	N/A	20 days	Sat 20/02/16	Thu 17/03/16
Manually Scheduled	End of the Paper	26 days	Sun 20/03/16	Fri 22/04/16
Manually Scheduled	Appendix	5 days	Sun 20/03/16	Thu 24/03/16
Manually Scheduled	References	5 days	Fri 25/03/16	Thu 31/03/16
Manually Scheduled	Bibliography	5 days	Fri 01/04/16	Thu 07/04/16
Manually Scheduled	Acknowledgements	5 days	Fri 08/04/16	Thu 14/04/16
Manually Scheduled	Web-Based Application	214 days	Wed 01/07/15	Fri 22/04/16

Manually Scheduled	Research & Reading	27 days	Wed 01/07/15	Thu 06/08/15
Manually Scheduled	Create a Gantt Chart in Microsoft Project	10 days	Wed 01/07/15	Tue 14/07/15
Manually Scheduled	Mind Map	10 days	Fri 17/07/15	Thu 30/07/15
Manually Scheduled	Create a Design for the Application	1 week	Fri 31/07/15	Thu 06/08/15
Manually Scheduled	Expand Research	10 days	Mon 10/08/15	Fri 21/08/15
Manually Scheduled	Create a BPMN diagram in Microsoft Visio	2 weeks	Mon 10/08/15	Fri 21/08/15
Manually Scheduled	Initial Design	69 days	Tue 01/09/15	Fri 04/12/15
Manually Scheduled	Design 1st Draft	66 days	Tue 01/09/15	Tue 01/12/15
Manually Scheduled	Test	2 days	Wed 02/12/15	Thu 03/12/15
Manually Scheduled	Preview to Supervisor	1 day	Fri 04/12/15	Fri 04/12/15
Manually Scheduled	Detailed Design	72 days	Fri 01/01/16	Fri 08/04/16
Manually Scheduled	Design Final Draft	69 days	Fri 01/01/16	Tue 05/04/16
Manually Scheduled	Test	2 days	Wed 06/04/16	Thu 07/04/16
Manually Scheduled	Preview to Supervisor	1 day	Fri 08/04/16	Fri 08/04/16
Manually Scheduled	Qualnet	3 days	Sun 10/04/16	Tue 12/04/16
Manually Scheduled	Test out: Effectiveness	1 day	Sun 10/04/16	Sun 10/04/16
Manually Scheduled	Test out: Speed	1 day	Mon 11/04/16	Mon 11/04/16

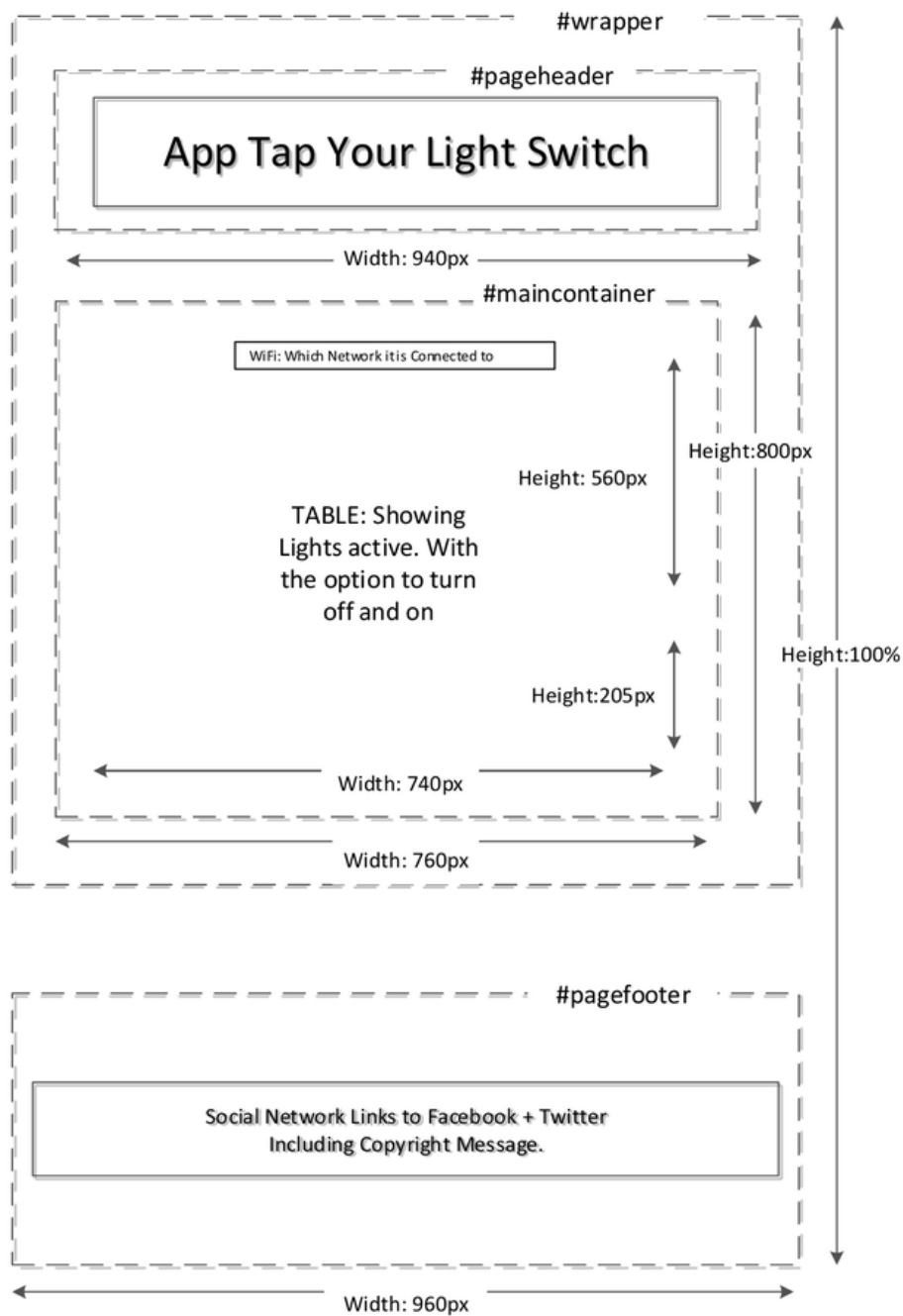
Manually Scheduled	Test out: Potential Ideas for Improvements	1 day	Tue 12/04/16	Tue 12/04/16
Manually Scheduled	Final Report	8 days	Wed 13/04/16	Fri 22/04/16
Manually Scheduled	Based on Qualnet Results Adapt the Application	1 week	Wed 13/04/16	Tue 19/04/16
Manually Scheduled	Test	1 day	Wed 20/04/16	Wed 20/04/16
Manually Scheduled	Final Preview to Supervisor	2 days	Thu 21/04/16	Fri 22/04/16



7.2.4 BPMN (Business Process Model Notation)



7.2.5 Schematic Diagram



7.2.6 Ethics Form

PROJECT RESEARCH APPROVAL FORM (Ethics)

Name:	Mr. Rhys Howells		
Project/Research Title:	The Internet of Everything – App Tap Your Light Switch		
Name of Supervisor:	Mr. Kapilan Radhakrishnan		
School/Dept.	School of Applied Computing		
Faculty:	FADE		
Proposed Start Date:	10/2015	End Date:	7/2016

1. Summary of planned research

My main premise of this project is, the world today needs to be 'more connected'. Based on research and analysis into the '*Internet of Everything*'. Improving how people implement such technology can promote this idea and moreover can push us into the right direction; towards the next stage of this evolution of connectivity.

The project aim is to develop a web-based application using php that can be used adjacently with a programmed raspberry pi and some electronic appliances (a relay, battery and a light bulb) to turn a lights state to on and off 'remotely'.

The survey will underline what the public of Swansea' views are on emerging technology and whether or not they would be interesting in projects such as the one proposed; or any other potential projects that could help persons to involve themselves with emerging technology.

Main Research Questions:

Is 'technology' an important factor in your life?

Would you like to see an improvement in technology in and around your 'household'?

These questions will help to understand the importance of technology compared to the end users views on the opportunity to add more improvements to technology to assist a person's life in and around their household. Based on other essential information from the survey, such as the gender and age range; the analysis of target audience can be introduced and therefore can

be used to pitch the project in the future to potential investors.

Overall, the survey is aimed to reassure the designers and the end user:

Can this product be effective enough to introduce to the public?

Is it a necessity to the end user?

Can It inspire future developers to promote connectivity in their products?

If these questions are answered, then the survey will be a success.

1. Methodology

☐ Interviews	☐ Participant Observation	☐ Use of personal data
☐ Focus groups	☒ Questionnaire	☐ Literature Review
☐ Performance	☐ Presentation	☐ Other (state below)*

2. Participants - Does your proposed project/research involve human participants?

☒ 1. Yes, as a primary source*	☐ 2. Yes, as a secondary source*	☐ No- go to section 4
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**If you have ticked yes, you are likely to need an Advanced CRB check before undertaking your study*

If yes, indicate who your participants are:

☐ Early years/Pre-School children	☒ Adults - give details below
☐ School age children	☐ Vulnerable people - give details below
☒ Young People aged 17-18	Second year undergraduate students.
☐ Unknown at this stage	

3. Other Ethical issues (*tick all that may apply to your research*)

☐

Administration of drugs incl. alcohol

☐

Deprivation

☐

Unpleasant stimuli in any manner or form

☐

Active deception or withholding information

☐

Collection of highly personal information

☐

Payment

4. Are there any ethical concerns other than those listed above?

Data to be collected includes information about persons views and opinions

5. If there are any ethical concerns, please state how you intend to minimise any risk of harm or distress that could be caused

The data will be stored and processed on a Swansea Metropolitan computer located in the office of the researcher. The computer is attached to a highly secure computer network and password protected. Only information related to the study will be held and any information connecting marks or submitted work with a student will be removed.

You should enclose the research proposal form, together with any materials (e.g. questionnaire, interview schedule) when submitting this form to your tutor/supervisor.

Student Signature

_____ Date _____

Supervisor's Signature

_____ Date _____

☐

Ethics clearance given at Faculty Level

☐

Clearance not given at Faculty level – forwarded for discussion at the next meeting of the University Ethics Committee. Details below:

Comments:

Chair's Initials

Date

Details on this form will be always be dealt with in accordance with the terms of the Data Protection Act 1998. The completed form will be retained on the student's file after approval (for audit purposes) and may be forwarded firstly to the Faculty Board and thereafter to the University Ethics Committee for a discussion of the issues highlighted.